NATIONAL BUREAU OF STANDARDS REPORT

4963

SIMULATED PERFORMANCE TESTS OF
BITUMINOUS PROTECTED METALS

by

Edward R. Oglio

U. S. DEPARTMENT OF COMMERCE
NATIONAL BUREAU OF STANDARDS

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Floor, Roof and Wall Coverings Section
Building Technology Division

Sponsored by

Office of the Chief of Engineers

Department of the Army

NBS

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ABSTRACT

Simulated performance tests were made on four bituminous protected metals representative of the product of three manufacturers. The tests included resistance to salt spray, accelerated durability conditions, shatter at low temperatures, and flame spread. Procedures for the tests were the same as used in an earlier series, but also included some modifications.

None of the materials was rated as having performed in an outstanding manner in all of the tests, although performances generally were either comparable to or superior to those reported previously for the same brand.

It is questionable whether the four materials should be compared directly with each other since one is of a distinctly different type from the other three. In three of them, a bituminous impregnated asbestos felt is used as part of the protective system for the steel basis sheet. A stabilized asphalt coating is used in the other.

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1. INTRODUCTION

Under letter of authorization dated 30 November 1954, reference ENGES, comparative simulated service tests of bituminous protected metals were undertaken for the Office of the Chief of Engineers, Department of the Army. Specimens, representative of the product of the three manufacturers as reported in an earlier series (N.B.S. Report 1808, "Tests of Bituminous Protected Metals", August 21, 1952), were subjected to laboratory tests of salt-spray, accelerated durability, low-temperature shatter, and flame spread resistance.

Although most of the tests from the previous series were repeated, the present series differed in several respects: (1) corrugated specimens were used in all tests; (2) the felted type products included specimens coated with bituminous

surfacing compound on both the weather side and the reverse side; (3) a low-temperature shatter resistance test at minus 30°F was added, and (4) a longer salt spray test was also used. Besides obtaining additional information on laboratory performance it was hoped that product improvement would be reflected by improved performance since, as stated earlier, most of the tests used in the previous series were repeated.

2. MATERIALS

The materials in this series were submitted by the Office of the Chief of Engineers, Department of the Army, and were standard corrugated sheets in twelve-foot lengths. It is understood that the sheets were obtained from the plants of the respective producers representing the following products:

1. Plasteel, a product of the Plasteel Products Corporation, which, according to the manufacturer, consisted of a treated steel sheet coated on both sides with stabilized asphalt and surfaced with flake mica. The basis steel sheet, weather-side coating, and reverse-side coating were calipered at 0.026, 0.017, and 0.013 in., respectively.

2. Galbestos C-2-S, a product of the H. H. Robertson Company, which, according to the manufacturer, consisted of a steel sheet coated on both sides with a bituminous-impregnated asbestos felt using metallic zinc as an adhesive. The felts on both the weather-side and the reverse side were surfaced with a mineral-stabilized, asphaltic protective coating. Thicknesses of the basis steel and the protective coatings were not obtained because these components could not be separated for measurement.

3. Galbestos C-1-S. This is also a product of the H. H. Robertson Company and, according to the manufacturer, differs from Galbestos C-2-S in that the reverse-side felt is not surfaced with the stabilized asphaltic protective coating. Thicknesses of the components were not obtained for the reason stated in the case of Galbestos C-2-S.

4. Steelbestos, a product of the American Steel Band Company, which according to the manufacturer, is similar to Galbestos C-2-S, except that a resinous adhesive, containing rust-inhibitive pigments, was used to bond the felts to the steel core. The basis steel sheet, weather-side protective system and reverse-side protective system were calipered at 0.028, 0.028, and 0.021 in., respectively.

3. TEST PROCEDURES

Test specimens were cut from the sheets by band saw, care being exercised to avoid damaging the weather-side coating system. Unless stated otherwise, specimens 10 X 12 in. were used.

3.1 Salt-Spray (Fog) Tests

Two specimens of each product were exposed to salt spray (fog) in accordance with the method described in Tentative Method of Salt-Spray (Fog) Testing, A.S.T.M. Designation: B117-44T.

The specimens were given a special protective treatment along all four edges. This was done by wrapping a pressure-sensitive aluminum foil adhesive tape over each edge and then coating with wax.

The specimens were placed in the test chamber with the weather sides facing the atomizer jets. After 30 days and 60 days of continuous exposure, specimens were removed from the cabinet, rinsed and allowed to dry one week in the laboratory and then were examined. Changes in external appearance, as evidenced by the appearance of blisters, cracks or rust on the surface, were noted. Adhesion was then determined by scraping with a putty knife. Finally, the core sheet was examined for indications of corrosion.

3.2 Accelerated Test for Durability

Raw-cut and edge-protected specimens, prepared as described in Section 3.1, were exposed in a low-intensity, enclosed carbon arc unit "Weatherometer Type HVKL-X", manufactured by the Atlas Electric Devices Company, Chicago, Illinois. Only one arc lamp, centrally located, was used as a source of radiation. The power consumption of the arc was approximately 1.8 kw.

The unit was operated continuously 22-1/2 hours per day. Each daily run was started with a 9-minute spray period which was repeated every hour. The water was introduced through four jets and delivered a total volume of approximately 90 gallons per hour at 20 pounds line pressure. The volume of water was such that the specimens were well washed by flowing water during each pass under the spray unit. The water temperature at the spray unit was approximately 25°C (77°F) and was essentially mineral and metal free (total solids less than 0.1 grain per gallon).

All piping, valves and spray jets were of aluminum. The temperature at the panel surfaces, measured with a black bulb mercury thermometer, ranged from 30°C (86°F) during the water spray to a maximum of 66°C (150°F) just prior to water spray. All specimens were exposed simultaneously; their positions being changed at fixed intervals to insure uniform weathering and washing.

Visual inspection was made after 350 hours. After 1000 hours the specimens were again visually inspected and then examined for loss of adhesion and corrosion of the basis metal.

3.3 Low-Temperature Shatter Resistance Test

The specimens were conditioned for 1 hour at two test temperatures (0°F and minus 30°F) and then were placed on a flat, firm, wooden support, 2- X 12- X 12-in., with the weather side uppermost. A 760-gram steel ball was then dropped from a height of 7 ft. and allowed to strike the surface of the specimen. The path of the ball was controlled so that it would strike the crest of a corrugation not less than 3 in. from any edge. After impact, the specimens were removed from the test chamber, allowed to warm to room temperature, and examined for shattering and loosening of the protective coating system.

Any coating that was knocked off by the impact of the steel ball was considered as shatter. Loose coating included shattered coating and any coating that could easily and readily be removed from the panel by lifting with the fingers, or with little force, by the use of a knife blade of similar instrument.

3.4 Flame Spread Tests

Two different tests were used. One was a "tunnel" test designed to study flame spread within a space enclosed on all sides except top and bottom, and the other was a "horizontal panel" test which indicates the spread of flame on the openly exposed under-surface of a slab or sheet of material supported in a horizontal position.

3.4.1 Tunnel Tests

The test specimen is placed as the cover or upper side of a tunnel, 12 ft long by approximately 40 in. wide and 9 in. deep, which is inclined at a slope of 5 in. vertical to 12 in. horizontal. The three fixed sides of the tunnel are of sheet metal lined with asbestos millboard. The igniting flame is applied to the under-surface of the specimen, at the lower end.

In the present tests, the specimens were so assembled as to have one joint running the 12 ft length, and they were placed with the surface intended for interior exposure faced downward and in contact with the flame. The igniting flame was applied for 35 minutes, and was produced by burning gas with a calorific value of approximately 1100 B.T.U./cu ft, at a rate of 3 cu ft/min for 30 minutes, and at a rate of 5 cu ft/min for 5 minutes. The length of the igniting flame, measured with an unprotected sheet metal cover in place of the test specimen, was about 2-1/2 feet.

3.4.2 Horizontal Panel Tests

This test is described in paragraph 4.3.3 of Federal Specification SS-A-118b for Acoustical Units: Prefabricated. The 36 inch square specimen is supported in a horizontal position on an angle iron frame, and a gas flame, automatically regulated to produce temperatures following a specified time-temperature curve, is applied to the center of the under-surface.

In the present tests, the 20-minute exposure, which reaches a maximum temperature of 794°C and is prescribed for Class C and Class D materials, was used. The materials were tested with the surface intended for interior exposure faced downward in contact with the flame. No backing could be applied to the specimens because of the corrugated form of the materials.

3.5 Outdoor Exposure Tests

Specimens, 4 ft long and cut the full width (40 in.) of the sheet, were placed on roof exposure racks on the roof of the Industrial Building at the National Bureau of Standards in Washington, D. C. The test racks are constructed so that the specimens are four feet above the regular roof deck and face south at an angle of 45° to the horizontal. No edge-protective treatment was given to the panels so that each has one raw-cut edge, the other three edges being left with whatever treatment was given in the course of production.

4. SUMMARY OF RESULTS

4.1 Salt-Spray (Fog) Test Results

This test is often used to indicate the comparative ability of coating systems to afford protection in a humid atmosphere where corrosive agents may be present. It is generally held that this is accomplished by revealing coating weaknesses such as cracks and pinholes, or comparatively low inherent resistance to moisture penetration in an otherwise continuous coating. These conditions may show up as small corrosion deposits or blisters on the surface of the coating, or as loss of adhesion between the protective system and the basis sheet.

Two exposure periods - 30 days and 60 days - were used in the present series. It is anticipated that some objection to the longer exposure will be made on the ground that 30 days (720 hours) is the maximum period specifically recommended in the Standard Method of Salt Spray (Fog) Testing (A.S.T.M. Designation B117-44T). However, heavy duty materials such as these products, justify the use of the longer exposure. Furthermore, considerably longer exposure periods - on the order of 200 days - have already been used in evaluating some types of protective coating (paint) systems for steel (B.M.S. Report 44, "Surface Treatment of Steel Prior to Painting").

<u>Plasteel</u>

During the thirty-day test, this product showed fairly good resistance to corrosion. The appearance of several rust spots on the coating indicated the existence of pinholes. Examination of the basis metal showed more extensive distribution of rust, but this appeared to be entirely on the

surface - no areas showing any appreciable penetration of the metal in depth. In these respects the results were comparable to those reported in 1952 (N.B.S. Report 1808).

The most pronounced effect of the test seemed to be on the adhesion of the coating. Loss of adhesion occurred to such an extent that the bituminous protective coating could, with practically no effort, be stripped in large sheets from approximately 80 percent of the test area. In this respect, performance was considerably poorer than in the 1952 series.

The 60-day test revealed the same type of weakness in the product. Rust on the basis sheet was about the same, while loss of adhesion was found to be more extensive than in the test of shorter duration.

Galbestos

Several small areas of zinc chloride deposits and a few pin-point sized areas of rust were the only deteriorative effects that were noted during the 30-day test. Again these are indicative of pinholes in the coating with the former indicating that the metallic adhesive was also functioning as a protective coating. These results were entirely comparable to those reported in 1952.

Except for the development of several small blisters, the 60-day test did not appear to be appreciably more deteriorative than the 30-day test. The blisters were between the bituminous surface coating and the impregnated felt and were not found to be associated with any corrosion when examined.

Adhesion of the felt remained excellent throughout the tests and could not be removed from the basis sheet even after the 60-day test. For this reason no evaluation of the condition of the basis metal could be made and consequently any corrosion beyond that exhibited on the bituminous surface coating, that might have been present, would go undetected.

Steelbestos

No blisters, but a few small rust spots, indicative of pinholes, were noted on the coating surface during the 30-day test. Adhesion of the felt, although somewhat less than at

the start of the test, was still rated as good. Examination of the basis metal showed six small rusted areas, the largest of which measured about 0.3 sq. in. In no case did the corrosion extend to any measurable depth into the metal.

In general, the product looked good and, because of the improved adhesion exhibited, performance was considered somewhat better than that reported in the 1952 series.

During the 60-day test, rust both on the surface coating and on the basis metal was more extensive than that reported for the 30-day test. Adhesion was poor over practically the entire test surface and the felt could easily be stripped from the specimen in relatively large sheets. Surface rust was found over 50% of the basis metal. The effect of the longer test period was striking, with regard to loss of adhesion and area of the basis metal showing rust.

4.2 Results of Accelerated Test for Durability

The accelerated durability test is in essence a procedure intended to produce rapid deterioration of bituminous materials under conditions simulating extreme outdoor exposure. This is accomplished by exposing the material to cycles of ultra-violet radiation, heat and water, the analogy to the natural agents, sunshine, heat and rain being obvious.

Numerous studies have established that, in general, a test of this type will produce in a relatively short time the principal types of failure (cracking, blistering, chalking, erosion, etc.) that a bitumen may exhibit during the longer course of natural weathering. However, no factor converting durability under accelerated test to durability under natural exposure has been established. Nevertheless, the accelerated test is of value in comparing similar materials, since it has been established that failure usually follows in the same order as in outdoor exposure.

The test as employed here can be considered primarily as an evaluative test of one component - the bituminous surfacing compound - of the total protective system. This is especially true of the felted products where this component is a

relatively thin layer. Nevertheless, this type of usage is considered valid since weakness in one component contributes to weakness in the protective chain. To have conducted the test so as to evaluate the total protective system would have required an inordinately long exposure.

Plasteel

Except for some loss of mica surfacing, this product exhibited no external effects from the exposure. No loss of adhesion and no corrosion of the basis metal was found. In these respects, the results duplicated those reported in the 1952 series.

Stabilized asphalt coatings of this type are known for their ability to withstand the erosive effects of both accelerated and outdoor weathering.

Galbestos

The C-2-S ("double coated") specimens exhibited blisters in the bituminous surfacing on both the sealed edge and raw (unsealed) edge specimens within 350 hours of exposure. At the end of the 1000 hours of exposure the surfacing was hard and brittle and chalking and hair cracks were observed, especially in the valleys. Adhesion of the felt and basis sheet appeared undiminished and was still rated as excellent. Except for the development of blisters on the raw (unsealed) edge specimens these results are entirely comparable to those reported in the 1952 series.

The results obtained with the C-1-S ("single coated") specimens were practically the same as with the C-2-S specimens with the exception of the raw-edge specimen. In this instance no blisters were found during the test period. These results are a duplication of those reported in 1952.

In general, the appearance was poor for both types of Galbestos. As indicated above, this was primarily due to the cracking and blistering that occurred in the bituminous surfacing compound. The almost total absence of rust (a few pinpoints were found on one of the four specimens) indicated that other elements of the protective system - most likely the zinc adhesive - were functioning during the exposure.

Steelbestos

Chalking and embrittlement of the coating were noted. No blisters, cracks or rust spots appeared nor was any loss in adhesion of the felt detected. In general, both specimens looked in good condition.

The absence of blisters, cracks and corrosion represent a marked improvement over the results reported for this product in the 1952 series.

4.3 Results of Low-Temperature Shatter Resistance Tests

Bituminous materials are susceptible to temperature. That is, they soften and are susceptible to flow at elevated temperature and become hard and brittle and susceptible to cracking and shattering at low temperature. In practice, protected metal sheets can be subjected to impact and shock during installation. This can occur in handling the sheets while unpacking and readying them for installation or when they are being fastened to the structure. After installation, shock and impact can occur at the lower siding courses or from hail or other missiles on the roofing courses. Damage to the protective system is not likely to be serious when the temperature is moderate. However, at low temperatures damage can be serious.

The low-temperature shatter resistance tests were designed to give some indication of the ability of protected metals to resist damage from impact and shock at low temperatures. Tests were made at 0°F for installations in temperate climates such as in the continental United States and at minus 30°F for installations in colder climates such as the arctic and sub-arctic regions.

Plasteel

At 0°F, shattering (coating that was knocked off the basis metal by the impact) occurred on the weather side (side of direct impact) to a total of 0.2 sq. in. of the surface area. The total area that was loosened from the basis metal measured 7.7 sq. in. While no coating shattered from the reverse side, loosening occurred over 1.2 sq. in. of the surface.

At minus 30°F, shatter averaged 0.6 sq. in. on the weather side with no shatter occurring on the reverse side. Loosening averaged 12.6 sq. in. and 1.8 sq. in., respectively.

As expected, damage to the bituminous protective coating was greater at the lower temperature. Also, damage to the coating was greater at 0°F than was recorded in the 1952 series. This could easily be due to (1) corrugated specimens were used in the present series, while flat sheets were used in 1952 and (2) the basis metal in the present series was of lower gage (0.026 in.) than in the earlier series (0.037 in.).

Galbestos

At 0°F, a small amount (less than 0.1 sq. in.) of the bitiminous surface coating shattered from the felt, both on the weather side and reverse side of the C-2-S ("double coated") type, which was the only type of this product tested at this temperature. Loosening of the felt occurred over an area of 0.8 sq. in. on the weather side and 0.2 sq. in. on the reverse side.

At minus 30°F, no shattering was noted on either side on both the C-2-S and C-1-S ("single coated") types. Loosening averaged 1.1 sq. in. on the weather side and 0.4 sq. in. on the reverse side for the C-2-S type, and 0.9 sq. in. and 0.1 sq. in. for the C-1-S type.

In all cases, loosening of the felt, as reported here for this product, did not involve clean disbonding from the adhesive or basis metal. It was a type of loosening or break within the felt since a thin layer of felt remained on the adhesive and could not be stripped from the metallic (zinc) adhesive, even in the areas classified as being loosened.

In general, damage to the protective coating system, where it did occur, can be rated as slight. This compares to no damage reported in the 1952 series. Again this might be due to the fact that corrugated specimens were used in the present series.

Steelbestos

No shatter occurred at either 0°F or minus 30°F. Loosening was detected over an area of 1.2 sq. in. on the weather side and 0.4 sq. in. on the reverse side at 0°F, and averaged 2.1 sq. in. and 0.4 sq. in., respectively, at minus 30°F.

Loosening in this case involved a weakening of bond partly between the felt and adhesive and partly between the adhesive and the basis metal.

In general, the results indicate that the protective coating of this product has good resistance to shock and impact at low temperatures. Damage, in the form of loss of felt adhesion, was somewhat greater than reported in 1952. The reasons for this are probably the same as stated under Plasteel.

4.4 Results of Flame Spread Tests

4.4.1 Results of Tunnel Tests

In general, the materials tended to melt quickly under contact of the flame, and to drip flaming globules onto the floor of the tunnel, where they continued to burn. With two of the products, however, this dripping occurred on only one of the specimens and came only from the joint directly above the flame. With all of the materials, the unexposed upper surface showed signs of softening over the full length to the top of the specimen.

4.4.2 Results of Horizontal Panel Tests

Three specimens of each of the four products were tested for compliance with Class C requirements, which stipulate that, under the prescribed test conditions, no flame from the specimen shall reach the angle frame at any point during or after the flame application, all flaming shall cease within 5 minutes after the test flame is discontinued, and no glow shall progress to the edge of the specimen at any point, during or after the test. Class D comprises those materials which fail to satisfy the Class C requirements.

4.5 Results of Outdoor Exposure

The following effects were noted when the specimens were inspected after 14 months of exposure:

Plasteel

Except for some loss of mica, no effects were observed.

Galbestos (C-1-S and C-2-S)

No changes were observed except a dulling of the surface coating and pinholes developing on the surface coating.

Steelbestos

A number of pin point spots of rust were noted in 5 of the 8 valleys on the specimen, while the surface elsewhere was dull in appearance. No other effects were noted.

5. CONCLUSIONS

In general, Plasteel and Galbestos showed about the same performance in the salt spray and accelerated durability tests as they did in the 1952 series. Steelbestos performed better in the present series. In resistance to shatter at 0°F, Galbestos and Steelbestos showed up about as well as in 1952, while Plasteel's performance was significantly poorer - perhaps for the reasons stated in Section 4.

In rating performance and making comparisons of the products in these tests, it should be noted that the tests are simulated performance tests, done on an accelerated scale in which various degradative factors are exaggerated. For example, in the salt spray tests the specimens were exposed continuously for 30 days and 60 days in an atmosphere of atomized 20% sodium chloride solution at 95°F. During much of this time the specimens were covered with a film of the solution which had settled from the fog in the test chamber. Also, it is questionable whether the products should be compared directly with each other, since one (Plasteel) is of a type distinctly different from the other three.

Nevertheless, in the absence of extensive service histories and despite the limitations mentioned, the tests are useful in making a general evaluation, especially of similar types. For this reason, performance ratings, based exclusively on the results of the tests described in this report, are given below. Where the adjective rating is the same, the product listed first was considered somewhat superior. Naturally, if the service history of a product is known to be at variance with a test result, it should not be penalized.

Salt-Spray Resistance

Galbestos C-2-S & C-1-S	-	Very Good
Plasteel	-	Good -- Fair
Steelbestos	-	Fair

Resistance to Accelerated Durability

Plasteel	-	Very Good
Steelbestos	-	Very Good
Galbestos C-1-S	-	Fair1/
Galbestos C-2-S	-	Fair1/

1/ Due to blistering of bituminous surface coating.

Low-Temperature Shatter Resistance

Galbestos C-1-S	-	Very Good
Galbestos C-2-S	-	Very Good
Steelbestos	-	Good
Plasteel	-	Poor

Flame Spread Resistance

The relative flame resistance of the four products as indicated by the two separate test methods agrees fairly well, although the methods differ considerably in conditions of fire exposure. On the basis of the tests made, Galbestos C-1-S, Plasteel, and Steelbestos would appear the most flame resistant of the group, and quite similar, although Steelbestos showed a greater tendency to melt and drip than the other two.

APPENDIX - TABLES OF RESULTS.

TABLE 1. SALT-SPRAY (FOG) TESTS

Product	Thirty-Day Exposure	Sixty-Day Exposure
Plasteel	Rust deposits noted in 6 places on coating. Adhesion was poor over 80% of the total area.	Rust stains, covering about 70% of test surface, was noted. Adhesion was practically nil over whole panel.
	Basis metal showed 3 areas of rust varying in size from 3/4 sq. in. to 4 sq. in., and 14 small areas varying from pin-point to 1/8 in. in diameter.	Basis metal showed rust to be comparable to the 30-day exposure test.
Galbestos C-2-S	Two pin-point sized rust spots and several other small areas of zinc chloride deposits noted on surface. No appreciable loss in adhesion of felt was noted.	Three small blisters noted on surface. Five small areas of rust and several similar areas of zinc chloride deposits also noted. No appreciable loss in adhesion of felt.
	The felt could not be stripped from the basis sheet. Therefore, the condition of the latter could not be rated.	Condition of basis metal not rated for the reason noted for 30-day exposure.
Galbestos C-1-S	Results were practically the same as for Galbestos C-2-S.	Results were practically the same as for Galbestos C-2-S.
Steelbestos	Six pin-point sized rust areas on coating surface. No blisters noted. Slight loss in adhesion of felt detected.	Pin-point sized rust areas more extensively distributed than after 30-days exposure. No blisters. Adhesion of the felt was poor over practically the entire panel surface.
	Basis metal showed six rusted areas varying in size from pin-point to 0.3 sq. in.	Rust and corrosion noted over approximately 50% of the basis metal.

TABLE 2. ACCELERATED TEST FOR DURABILITY

Name	Edges Sealed	After 350 Hrs.	After 1000 Hrs.
Plasteel	Yes	No defects noted.	Slight loss of mica flakes. No defects noted. Adhesion of coating to metal was good.
Plasteel	No	No defects noted.	Slight loss of mica flakes. No defects noted.
Galbestos C-2-S	Yes	Moderate blistering.	Severe blistering over 100% of area. A few pin points of rust on surface. Coating hard and brittle and cracking developed. No loss of adhesion noted between felt and metal. Chalking noted.
Galbestos C-2-S	No	Moderate blistering.	Approximately same as above.
Galbestos C-1-S	Yes	Slight to moderate blistering.	Severe blistering over 100% of area. Coating was hard and brittle and cracking, more pronounced in the valleys, had developed. No loss of adhesion was noted between felt and metal. Chalking noted.
Galbestos C-1-S	No	No defects noted.	Chalking noted. Small longitudinal cracks beginning to develop in valleys. No other defects noted.
Steelbestos	Yes	No defects noted.	Chalking of protective coating noted. No other defects. No loss of adhesion between felt and metal. No corrosion on basis metal.
Steelbestos	No	Slight blistering along one edge.	Chalking of protective coating noted. Slight pitting along one edge where small blisters have broken. Coating was hard and brittle. No loss of adhesion between felt and metal. No corrosion noted on basis metal.

TABLE 3. LOW-TEMPERATURE SHATTER RESISTANCE TESTS

Product	Tests at 0°F: Shatter, sq. in. — Weather Side	Tests at 0°F: Shatter, sq. in. — Reverse Side	Tests at 0°F: Total Loosening, sq. in. — Weather Side	Tests at 0°F: Total Loosening, sq. in. — Reverse Side	Tests at Minus 30°F: Shatter, sq. in. — Weather Side	Tests at Minus 30°F: Shatter, sq. in. — Reverse Side	Tests at Minus 30°F: Total Loosening, sq. in. — Weather Side	Tests at Minus 30°F: Total Loosening, sq. in. — Reverse Side
Plasteel								
1	0.2	0.0	7.7	1.2	1.1	0.0	11.7	1.2
2					0.0	0.0	13.5	2.5
Aver.					0.6	0.0	12.6	1.8
Galbestos C-2-S								
1	L0.1	L0.1	0.8	0.2	0.0	0.0	1.2	0.3
2					0.0	0.0	1.0	0.4
Aver.					0.0	0.0	1.1	0.4
Galbestos C-1-S								
1					0.0	0.0	1.0	0.2
2					0.0	0.0	0.8	0.0
Aver.					0.0	0.0	0.9	0.1
Steelbestos								
1	0.0	0.0	1.2	0.4	0.0	0.0	2.4	0.3
2					0.0	0.0	1.8	0.4
Aver.					0.0	0.0	2.1	0.4

TABLE 4a. TUNNEL TEST (FLAME SPREAD)

Material	Dripping	Maximum Flame Spread 0-30 min.	Maximum Flame Spread 30-35 min.
Galbestos C-2-S	at 4 min.	12 in.	filled tunnel extending out top
Galbestos C-1-S	from 1 specimen only, at joint above flame	6 in.	3 ft.
Plasteel	from 1 specimen only, at joint above flame	6 in.	4-1/2 ft.
Steelbestos	at 3 and 4 min. respectively	2 and 4 ft. respectively	7 ft.

TABLE 4b. HORIZONTAL PANEL TEST (FLAME SPREAD)

Material	Dripping	Diameter of Flaming Area	Rating
Galbestos C-2-S	Yes	30 in.	D
Galbestos C-1-S	No	8 in.	C
Plasteel	No	18 in.	C
Steelbestos	No	12 in.	C

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